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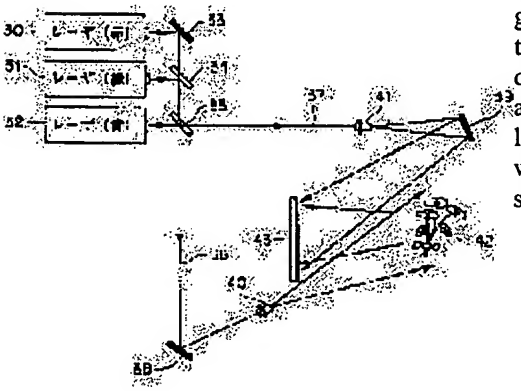
(54) ILLUMINATION DEVICE FOR LIQUID CRYSTAL FOR COLOR DISPLAY



(57)Abstract:
PROBLEM TO BE SOLVED: To provide an illumination device for a liquid crystal for color display which uses white light as the light source and which maintains proper white balance of the reproduced light reflected by the hologram of a light guide plate.
SOLUTION: The illumination device of a liquid crystal display device has a light guide plate and illuminates the liquid crystal for color display with a light, reflected by the hologram formed on the reflection face of the light guide plate. The illumination device is provided with a light source, which uses LEDs of three colors of red, green and blue and mixes the lights emitted from the LEDs of three colors, to produce white light, and with a light guide plate having a hologram which reflects the light of wavelengths near the wavelengths of the red, green and blue color light from the light source with higher efficiency than the lights of other wavelengths.

LEGAL STATUS

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CLAIMS

[Claim 1] The lighting system of the liquid crystal display which illuminates color display liquid crystal by the light reflected by the hologram which has a light guide plate and was formed in the reflector of this light guide plate characterized by providing the following. The light source which uses Light Emitting Diode which emits light in the light of red, green, and three blue colors, mixes the light which emits light from Light Emitting Diode of these three colors, and is made into the white light. The light guide plate in which the hologram reflected at the efficiency in which the light of the wavelength approximated to the wavelength of the light of the red of this light source, green, and three blue colors is higher than the light of other wavelength was formed.

[Claim 2] The lighting system of the color display liquid crystal according to claim 1 to which the hologram which reflects the light of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors at high efficiency is characterized by being the hologram by which multiplex exposure was carried out with the laser of the red of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors, respectively, green, and three blue colors.

[Claim 3] Light Emitting Diode which emits light in the light of the red of the aforementioned light source, green, and three blue colors is the lighting system of the color display liquid crystal according to claim 2 characterized by choosing and adopting three kinds of Light Emitting Diodes of a predetermined form which emits light in the light of the wavelength approximated to the wavelength of the light of the laser of the aforementioned red which exposes the aforementioned hologram, green, and three blue colors.

[Claim 4] Light Emitting Diode which emits light in the light of the red of the aforementioned light source, green, and three blue colors is the lighting system of the color display liquid crystal according to claim 3 characterized by inspecting the group of many Light Emitting Diodes of the aforementioned predetermined form, and using only Light Emitting Diode which emits light in the light of the wavelength approximated to the wavelength of the light of the laser of the aforementioned red which exposes the aforementioned hologram, green, and three blue colors, sorting out it individually.

[Claim 5] The hologram reflected at the efficiency in which the light of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors is higher than the light of other wavelength A hologram is formed so that it may become the maximum efficiency in each wavelength of the laser of the aforementioned red, green, and three blue colors. a white balance The lighting system of the color display liquid crystal according to claim 1 to 4 characterized by adjusting by choosing and adopting IF current of each Light Emitting Diode, and the rank of brightness in Light Emitting Diode which emits light in the light of the red of the aforementioned light source, green, and three blue colors.

DETAILED DESCRIPTION

[0001]
[The technical field to which invention belongs] About the lighting system which illuminates color display liquid crystal, especially, this invention illuminates color display liquid crystal by the white light, and relates to the lighting system of the color display liquid crystal which reproduces correctly the color of the character displayed on color display liquid crystal, or a picture.

[0002]
[Description of the Prior Art] It has the light source which consists of a white Light Emitting Diode (light emitting diode), and the light guide plate with which the hologram was formed as a reflector in the lighting system which illuminates color display liquid crystal, and there is a lighting system which projects this light reflected in respect of the hologram on color display liquid crystal, and illuminates it among them. This lighting system has small power consumption, is very lightweight, and since it can be made a thin shape, it is used. [on portable small electronic equipment, such as a cellular phone,] [many]

[0003] However, white Light Emitting Diode forms and constitutes the YAG fluorescence layer 53 on the upper surface of blue Light Emitting Diode52 formed on the substrate 51, as shown in drawing 5 . A part of blue light on which it was projected from blue Light Emitting Diode52 excites the YAG fluorescence layer 53. It becomes the white light by carrying out color mixture of the light yellow which has the relation of the complementary color which emits light from the YAG fluorescence layer 53 to a blue light which the YAG fluorescence layer 53 is made to emit light in light yellow, and emits light from blue Light Emitting Diode52. Therefore, it is known that the distribution of the luminous intensity to the wavelength of this white light will serve as a color which wore the green or the purple-blue color which reproduction light lost the balance (white balance) of a color, and was somber when it has the blue peak A and the peak B of light yellow and this was reflected in respect of the hologram of a light guide plate as shown in drawing 6 .

[0004] In order to correct this white balance, although a hologram must be made into the hologram which makes red (wavelength is about 620nm) light the maximum diffraction efficiency, in this case Diffraction efficiency of the light of other wavelength other than red will be made low, the luminous intensity reflected in respect of a hologram will decrease as a whole, the quantity of light which illuminates color display liquid crystal decreases, and the lighting light which illuminates color display liquid crystal is not darkly avoided with a bird clapper. Moreover, when the wavelength of a reproduction reference beam differed, and it was known that dotage will arise in reproduction light, a hologram was irradiated by having made this white light into the reproduction reference beam and it reproduced from the property of a hologram, since the peak was in two places of blue and light yellow, this white luminous intensity was difficult for dotage arising between a blue light and the light of light yellow, and maintaining the whole white balance good.

[0005]
[Problem(s) to be Solved by the Invention] this invention cancels the trouble of such conventional technology, and aims at offering the lighting system of color display liquid crystal which can maintain the white balance of the reproduction light reflected by the hologram formed in the reflector of a light guide plate good in the lighting system of the color display liquid crystal which uses the white light as the light source.

[0006]
[Means for Solving the Problem] In the lighting system of the liquid crystal display which illuminates color display liquid crystal by the light reflected by the hologram which has a light guide plate and was formed in the reflector of this light guide plate in order that this invention might solve the trouble of such conventional technology The light source which uses Light Emitting Diode which emits light in the light of red, green, and three blue colors, mixes the light which emits light from Light Emitting Diode of these three colors, and is made into the white light, The light of the wavelength approximated to the wavelength of the light of the red of this light source, green, and three blue colors offers the lighting system of the color display liquid crystal characterized by having the light guide plate in which the hologram reflected at efficiency higher than the light of other wavelength was formed.

[0007] The hologram which reflects the light of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors at high efficiency here The red of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors, respectively, Light Emitting Diode to which it is desirable that it is the hologram by which multiplex exposure was carried out, and it emits light with the laser of green and three blue colors in the light of the red of the aforementioned light source, green, and three blue colors It is desirable to choose and adopt three kinds of Light Emitting Diodes of a predetermined form which emits light in the light of the wavelength approximated to the wavelength of the light of the laser of the aforementioned red which exposes the aforementioned hologram, green, and three blue colors. Furthermore, as for Light Emitting Diode which emits light in the light of the red of the aforementioned light source, green, and three blue colors, it is desirable to inspect the group of many Light Emitting Diodes of the aforementioned predetermined form, and to use only Light Emitting Diode which emits light in the light of the wavelength approximated to the wavelength of the light of the laser of the aforementioned red which exposes the aforementioned hologram, green, and three blue colors, sorting out it individually.

[0008] Or the hologram reflected at the efficiency in which the light of the wavelength approximated to the wavelength of the light of the red of the aforementioned light source, green, and three blue colors is higher than the light of other wavelength A hologram is formed so that it may become the maximum efficiency in each wavelength of the laser of the aforementioned red, green, and three blue colors. a white balance In Light Emitting Diode which emits light in the light of the red of the aforementioned light source, green, and three blue colors, it is desirable to adjust by choosing and adopting IF current of each Light Emitting Diode and the rank of brightness.

[0009]
[Embodiments of the Invention] Hereafter, the detail of this invention is explained based on the drawing in which an example is shown. Drawing 1 or drawing 3 is the ** type view showing one example of the liquid crystal display which adopted the lighting system of the color display liquid crystal of this invention, and the penetrated type liquid crystal display with which drawing 1 used the back light, the transflective LCD with which drawing 2 used the back light, and drawing 3 are the examples of the reflected type liquid crystal display which used the front light.

[0010] The light on which it was projected from the light source 10 diffuses each of these liquid crystal displays with a light guide plate 11. It is that on which it is projected by becoming lighting light toward the liquid crystal display panel 12. The liquid crystal display of the penetrated type which the lighting system which consists of the light source 10 and light guide plate 11 grade is in the tooth-back side of the liquid crystal display panel 12, serves as a back light, and illuminates, or a transflective type (drawing 1 and drawing 2), To what a lighting system is in the tooth-back side of the liquid crystal display panel 12, and there is a reflected type liquid crystal display (drawing 3) which serves as a front light and is illuminated, serves as a back light, and is illuminated The lighting of the liquid crystal display panel 12 has a penetrated type liquid crystal display (drawing 1) only by the back light, and the transflective LCD which will turn on a back light and will be illuminated by the back light if it illuminates with the luminosity of outdoor daylight and a luminosity runs short when outdoor daylight is bright enough.

[0011] With any liquid crystal display, since the fundamental composition of the liquid crystal display panel 12 is the same, the structure of the liquid crystal display panel 12 is explained collectively here. The liquid crystal display panel 12 has fundamentally the structure where liquid crystal 15 was inserted between two glass substrates 13 and 14, as everyone knows, and in this example, since it is color display liquid crystal, the light filter 16 is arranged at the upper glass-substrate 13 bottom. And the TFT side 17 is formed in the upper surface of the lower glass substrate 14.

[0012] In the penetrated type liquid crystal display which used the back light of drawing 1 , polarizing plates 18 and 19 are arranged at the upper and lower sides of this liquid crystal display panel 12, and the condensing sheet or the diffusion sheet 20 which prepares the light on which it is projected toward the liquid crystal display panel 12 from the light source 10 which constitutes a back light to the liquid crystal display panel 12 down side, a light guide plate 11, and a light guide plate 11 is arranged.

[0013] Moreover, the one-way mirror 21 which makes the transflective LCD which used the back light of drawing 2 penetrate the light on which it is projected toward the liquid crystal display panel 12 from a light guide plate 11 when the light which penetrated the liquid crystal display panel 12 is reflected when making outdoor daylight into lighting light, and a back light is used is arranged between the polarizing plate 19 of the liquid crystal display panel 12 bottom, the condensing sheet of a lighting system, or the diffusion sheet 20.

[0014] Furthermore, in the reflected type liquid crystal display which used the front light of drawing 3 , the light source 10 and the light guide plate 11 which constitute a front light are arranged at the liquid crystal display panel 12 bottom, and the polarizing plate 23 which has the compensation function prepared while polarizing the light on which it is projected toward the liquid crystal display panel 12 between a light guide plate 11 and the liquid crystal display panel 12 is arranged. Moreover, the reflective film 22 is formed in the upper surface of the lower glass substrate 14. This reflective film 22 reflects the lighting light (outdoor daylight is included) on which it is projected from the upper part, and may prepare it in the lower glass-substrate 14 bottom as a reflecting plate.

[0015] Here, in this example, in order to reflect the light which it was projected from the light source 10 and carried out incidence to the light guide plate 12 and to project toward the liquid crystal display panel 12, the reflector by the hologram is formed in the reflector (the example of drawing 2 the field of a light guide plate 11 top and the example of drawing 3 drawing 1 and lower field) of a light guide plate 11. The reflector by this hologram sticks the sheet which formed the hologram in the reflector of a light guide plate 12, or formed the hologram, when the light which diffuses and spreads the inside of a light guide plate 12 reaches a reflector, it can be diffracted by the hologram, can project reproduction light toward the liquid crystal display panel 12, and can be made to reflect it with the uniform quantity of light over the whole surface of a reflector. Therefore, the word of "reflecting by the hologram" in this specification means what "it diffracts by the hologram and reproduction light is projected for toward the liquid crystal display panel 12."

[0016] However, as mentioned above, in having used white Light Emitting Diode of the conventional technology as the light source, making the white balance of reproduction light good has the difficult fault. for this reason, in the lighting system of the color display liquid crystal of this invention, it is not white Light Emitting Diode of the conventional technology about the light source 10, and three Light Emitting Diodes which emit light in the light of red, green, and three blue colors are used, and the white balance which is

reproduction light is made good by mixing the light which emits light from Light Emitting Diode of these three colors, and considering as the white light Here, even if three Light Emitting Diodes which emit light in the light of these three colors manufacture three Light Emitting Diodes individually, they are natural. [of your forming so that it may be united on one substrate]

[0017] for this reason, in the lighting system of the color display liquid crystal of this invention While using Light Emitting Diode which emits light in the light of red, green, and three blue colors as the light source 10, mixing the light which emits light from Light Emitting Diode of these three colors and considering as the white light The light of the wavelength approximated to the wavelength of the light of the red which emits light from Light Emitting Diode of this light source 10, green, and three blue colors as a hologram formed in the reflector of a light guide plate 12, respectively forms in the reflector of a light guide plate 12 the hologram reflected at efficiency higher than the light of other wavelength.

[0018] By forming such a hologram in the reflector of a light guide plate 12 Since the light which emits light from Light Emitting Diode of the red used as the light source 10, green, and three blue colors reflects by the hologram at high efficiency and it stops almost reflecting the light of other wavelength Most light on which it is projected toward the liquid crystal display panel 12 from the hologram formed in the reflector of a light guide plate 12 turns into light which emits light from the red, the green, and blue Light Emitting Diode of the light source 10, and can acquire the white light which was excellent in the white balance by compounding these three colors.

[0019] Reflecting the light of the specific wavelength which emits light hereafter from Light Emitting Diode of the red used as the light source 10, green, and three blue colors at high efficiency, the light of other wavelength explains the hologram which is not reflected as much as possible.

[0020] Drawing 4 is the conceptual diagram showing the optical system for forming such a hologram. As shown in drawing, as the light source which forms the hologram of this invention, the laser 30, 31, and 32 of red, green, and three blue colors is used, and the hologram by which multiplex exposure was carried out is formed. That is, the laser beam on which it was projected from the red laser 30, the green laser 31, and the blue laser 32 is made into the light on the same optical axis by the mirror 33 and beam splitters 34 and 35, and it divides into the body light 36 and a reference beam 37 by the beam splitter 35, and the body light 36 is projected on a body (mirror in this case) 42 through a mirror 38 and an objective lens 40, and it is projected by the sensitive material 43 with which the reflected light was Moreover, it is projected on a reference beam 37 by sensitive material 43 through a mirror 39 and an objective lens 41, the reflected light and the reference beam 37 of the body light 36 interfere, and a hologram is formed in sensitive material 43.

[0021] Thus, the hologram formed by piling up the laser 30, 31, and 32 of red, green, and three blue colors, and carrying out multiplex exposure turns into a hologram which reflects the light of the wavelength approximated to the wavelength of the laser beam on which it is projected from the laser 30, 31, and 32 of red, green, and three blue colors at high efficiency. The hologram of the sheet which copied the hologram which copied the hologram obtained by doing in this way, or the hologram being stuck actually formed in a light guide plate 11 as a reflector is natural.

[0022] Since it changes with form of Light Emitting Diode in which the brightness of the light of the red on which it was projected from the light source 10, green, and three blue colors was chosen at this time, the light diffracted as a reproduction light by the hologram formed as a reflector of a light guide plate 12 does not necessarily turn into the perfect white light. For this reason, the output of laser can be controlled and the diffraction efficiency in the wavelength of each color can be adjusted so that the white balance of a fixed level may be maintained.

[0023] Or the white balance of the light diffracted by the hologram which the output of the laser at the time of forming a hologram formed the hologram as diffraction efficiency became the maximum in the wavelength of each color, and was formed in the reflector of a light guide plate 12 can also be adjusted by choosing the rank of each IF current of Light Emitting Diode which emits light in the light of the red, the green, and three blue colors used as the light source, or brightness. This method becomes what white balance, or it is not necessary to control the output of laser and to decide a white balance at the time of formation of the hologram which is not clear, and since the rank (partition of the luminosity of Light Emitting Diode) of the value of IF current (current passed to Light Emitting Diode) of Light Emitting Diode or brightness can be chosen according to the hologram of the completed light guide plate 12, it becomes easier to maintain a white balance on fixed level.

[0024] Thus, since the formed hologram diffracts the light of the same wavelength as the wavelength of the laser used when forming a hologram as a reproduction light at the highest efficiency, as for Light Emitting Diode used as the light source 10, it is desirable [a hologram] to choose and adopt the form of the red which emits light in the light of the wavelength approximated as much as possible to the wavelength of laser, green, and three kinds of blue Light Emitting Diodes out of Light Emitting Diode of various kinds of form. It is desirable for peak emission wavelength to use red Light Emitting Diode of form, such as 605nm, 612nm, and 615 etc.nm, as the light source, when it follows, for example, wavelength forms a hologram as red laser using the He Ne laser which is 632.8nm, and when using the krypton laser whose wavelength is 647.1nm, it is desirable for peak emission wavelength to use red Light Emitting Diode of form, such as 660nm and 700 etc.nm, as the light source.

[0025] When similarly wavelength forms a hologram as green laser using the argon laser which is 514.5nm, in the YAG laser whose wavelength green Light Emitting Diode of form in which peak emission wavelength is set to 515nm is 532.0nm, green Light Emitting Diode of form in which peak emission wavelength is set to 527nm or 530nm is desirable. Moreover, when wavelength uses the argon laser which is 488.0nm as blue laser, in the argon laser whose wavelength blue Light Emitting Diode of form in which peak emission wavelength is 472nm or 470nm is 457.9nm, green Light Emitting Diode of form, such as 428nm, 470nm, and 472 etc.nm, has desirable peak emission wavelength.

[0026] This relation can also be made reverse. For example, when using the red Light Emitting Diode of form in which peak emission wavelength is set to 605nm, as the light source, in case a hologram is formed, it is most desirable to adopt the He Ne laser whose wavelength is 632.8nm. Since it is similarly materialized about other Light Emitting Diodes, this omits examining all Light Emitting Diodes here.

[0027] Furthermore, even if it is Light Emitting Diode of the same form when searching for still higher white balance and efficiency since the variation in a manufacturing process etc. becomes a cause and variation arises also in the peak emission wavelength of Light Emitting Diode, it is desirable to use only Light Emitting Diode which emits light in the light of near wavelength with the wavelength of each light of the laser of three colors which inspected individually the peak emission wavelength of the group of Light Emitting Diode of manufactured a large number, sorted out it, and exposed the hologram. This inspection is good also as total inspection, when it can ask for carrying out a sampling inspection for every lot, and doubling wavelength more strictly.

[0028] As mentioned above, although the lighting system of the color display liquid crystal of this invention was explained, this invention of the ability of various kinds of change and improvement to be performed in the range which is not limited to the gestalt of the operation described above and does not deviate from the summary of this invention is natural.

[0029]
[Effect of the Invention] As explained above, the lighting system of the color display liquid crystal of this invention as the light source Red, Light Emitting Diode which emits light in the light of green and three blue colors is used, and the light of three colors which emit light from this Light Emitting Diode is mixed, and it considers as the white light. to the reflector of a light guide plate Since the hologram which reflects the light of the wavelength approximated to the wavelength of the light of the red of this light source, green, and three blue colors at high efficiency is formed Reflect the light of three colors which emit light from Light Emitting Diode used as the light source at the maximum efficiency, and the reflector of the light guide plate in which the light of other wavelength does not carry out deer reflection only is obtained. It becomes the white light which only the light of three colors of Light Emitting Diode which mainly serve as the light source mixed, and the possible light source of maintaining the white balance of the reproduction light reflected by the hologram of a light guide plate good can offer the lighting system of the color display liquid crystal of the white light.

DESCRIPTION OF DRAWINGS

[Drawing 1] It is the cross section showing one example of the liquid crystal display which adopted the lighting system of the color display liquid crystal of this invention, and the penetrated type liquid crystal display which used the back light is shown.
[Drawing 2] It is the cross section showing one example of the liquid crystal display which adopted the lighting system of the color display liquid crystal of this invention, and the transflective LCD which used the back light is shown.
[Drawing 3] It is the cross section showing one example of the liquid crystal display which adopted the lighting system of the color display liquid crystal of this invention, and the reflected type liquid crystal display which used the front light is shown.
[Drawing 4] It is the conceptual diagram showing the optical system for forming the hologram which reflects the light of specific wavelength at high efficiency.
[Drawing 5] It is the ** type view showing the cross-section configuration of white Light Emitting Diode.
[Drawing 6] It is the graph which shows the distribution for every wavelength of the light of white Light Emitting Diode.

[Description of Notations]
10 Light Source
11 Light Guide Plate
12 Liquid Crystal Display Panel
13 14 Glass substrate
15 Liquid Crystal
16 Light Filter
17 TFT Side
18 19 Polarizing plate
20 Condensing Sheet or Diffusion Sheet
21 One-way Mirror
22 Reflective Film
23 Polarizing Plate Which Has Compensation Function
30, 31, 32 Laser
33 Mirror

34 35 Beam splitter
36 Body Light
37 Reference Beam
38 39 Mirror
40 41 Objective lens
42 Body
43 Sensitive Material

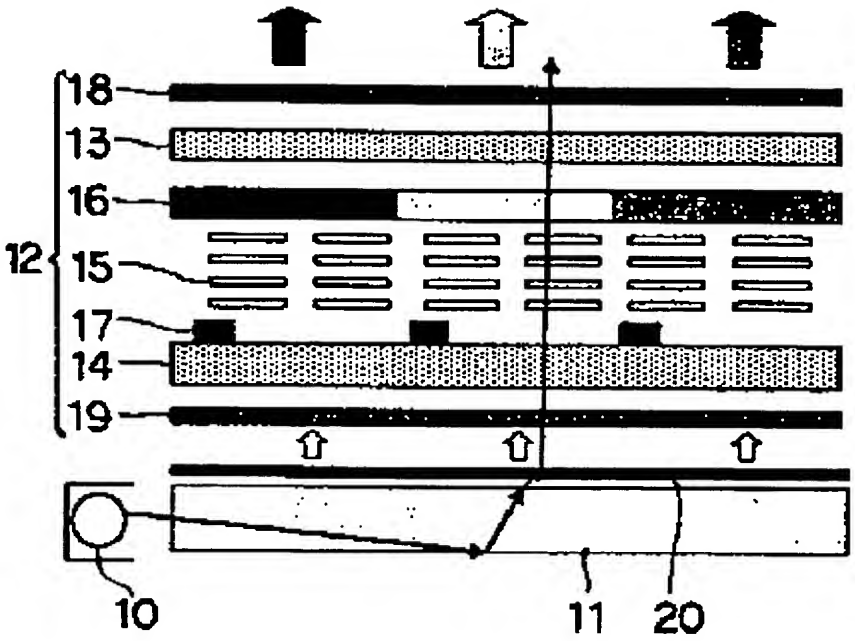

FIG 1

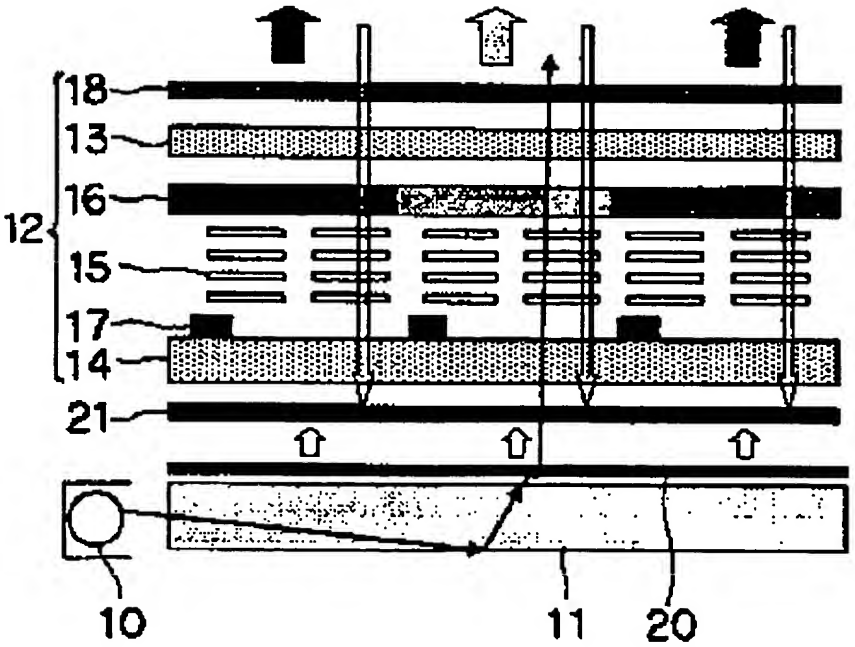

FIG 2

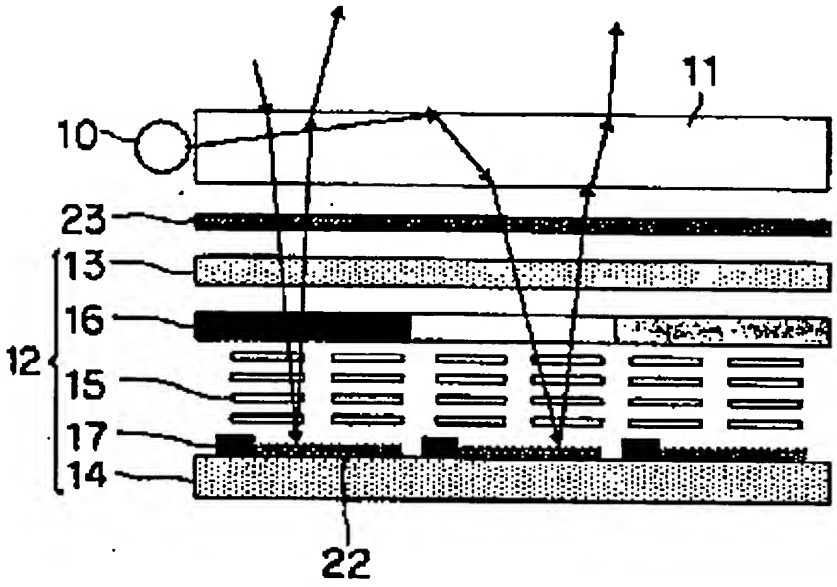
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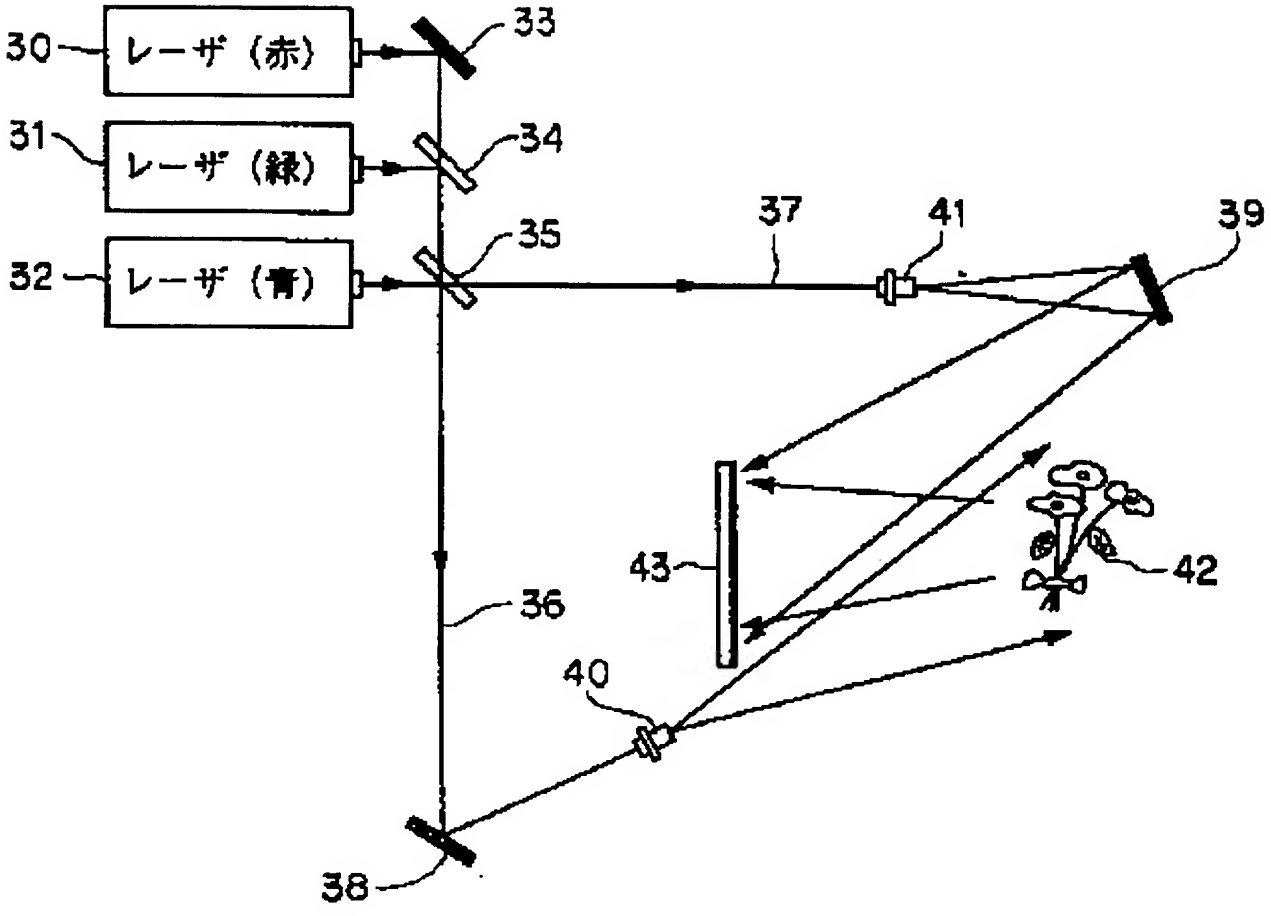
FIG 3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レーザ（赤）
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レーザ（緑）
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レーザ（青）
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FIG 4

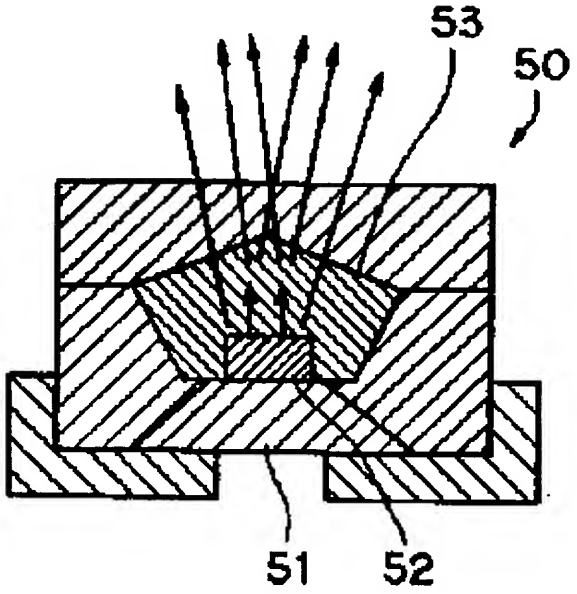

FIG 5

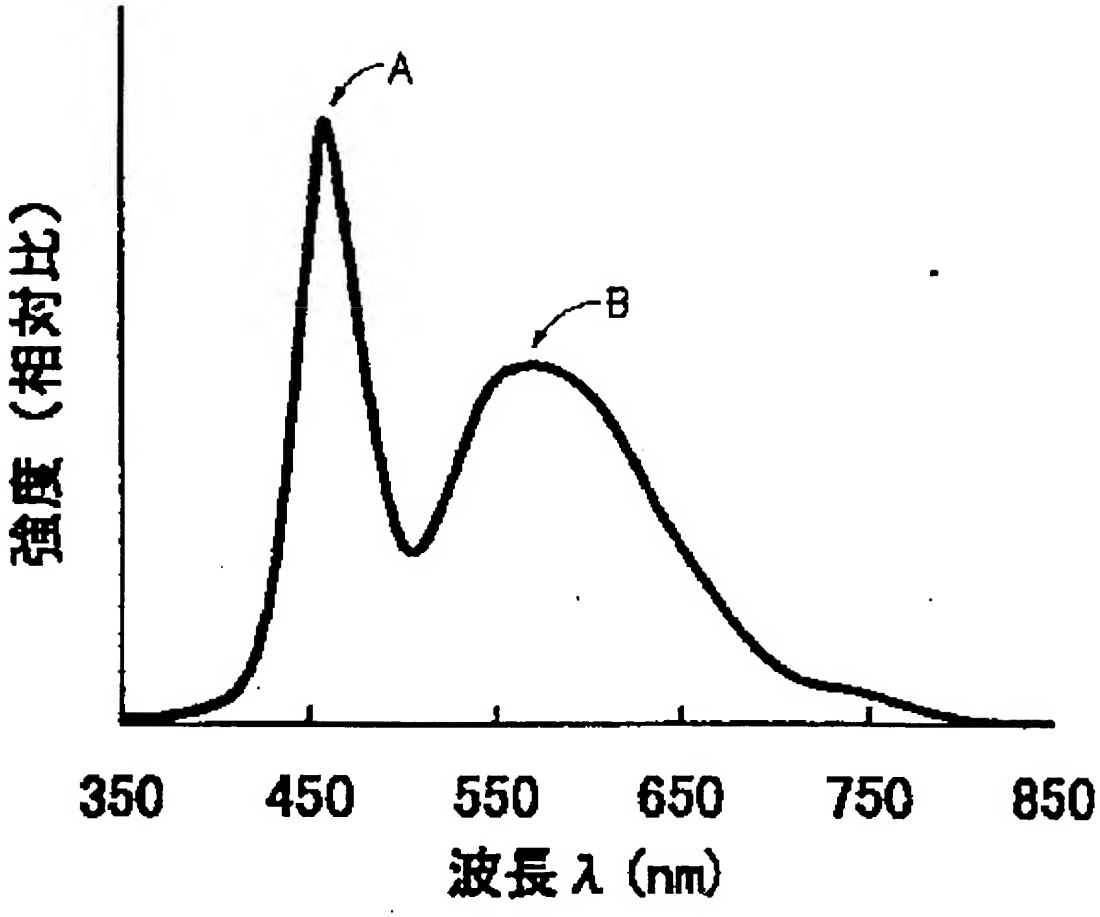

FIG 6